#2167

United States
Department
of Agriculture

Forest
Service

Alaska
Region

Forest Health Protection Report

Resurrection Creek Permanent Plots Revisited

Technical Report
R10-TP-89
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Introduction:
Kenai Peninsula forests have historically been subject to fire and spruce beetle outbreaks. Fires have been documented since the turn of the century (Potkin 1997). Spruce beetle (*Dentroctonus rufipennis*) infestations have been most significant in the past two decades (Holsten et al. 1999, USDA 1998). These disturbance agents have greatly influenced the present forest communities at landscape levels. Surviving plant species and the effects of fire, beetles, and other disturbances will determine future forest plant communities.

Fire is an indiscriminant disturbance agent; it effects all vegetation, to some degree. Plant species vary in susceptibility and response to fire, and fire usually moves across the landscape unevenly. Depending on fire intensity, mineral soil may or may not be exposed. This results in a mosaic of recovering vegetation community types. All tree species on the Kenai are susceptible to fire, but birch (*Betula neoalaskana*) and aspen (*Populus tremuloides*) can sprout from stumps and roots following fire.

Spruce beetles are selective; they normally infest and kill mature spruce (*Picea spp.*) trees. However, other vegetation in the affected forest communities will respond to the changes in overstory conditions. Dead spruce trees may remain standing for years, but they no longer compete for nutrients or water. Needles and fine branches begin to drop within a year or two after death, allowing more sunlight to reach the forest floor. Generally, as more sunlight reaches the forest floor, sun-loving plant species respond with increased growth. When dead trees begin to fall, they snap off along the trunk, at the base of the tree, or pull up a root wad. Mineral soil is exposed only in the latter case.

One frequently observed change that occurs following loss of forest overstory is an increase of bluejoint reed grass (*Calamagrostis canadensis*). Bluejoint grows best in full sunlight, on moist, nutrient rich sites (Lieffers et al. 1993). It is rare to absent under a closed forest canopy, but plants that are present rapidly expand by rhizome growth when the tree canopy is removed (Powelson and Lieffers 1992). Bluejoint is a significant competitor with young tree seedlings and impedes seedling establishment. It produces a dense, continuous sod and litter layer. When seeds fall into this matrix they may germinate, but then the sprouts wither and die as the litter dries out (Haeussler et al. 1990).

Eventually, bluejoint declines in vigor and biomass production is reduced (Soulupova 1992). Abundant standing dead shoots and litter insulate the ground and reflect light, delaying thaw for 2-3 weeks (Hogg and Lieffers 1990). Nutrients are tied up in the dead organic matter; older grass stands can become chlorotic. Light fires can rejuvenate grass by removing thatch, releasing nutrients, and warming the soil. Intense fires, however, destroy rhizomes and can reduce grass occupancy (Lieffers et al. 1993). The length of time that bluejoint dominates is not well documented in Alaska. Regardless, bluejoint is an important species to consider when making predictions on the composition of future forests following disturbance.

Purpose:
The Chugach National Forest (CNF) is in the process of a Forest Plan Revision. To aid planners, managers, and interested public in articulating wants and needs of future forest conditions, a vegetation assessment is being conducted. There are two main components involved:

1. Quantify and describe existing vegetation communities.
2. Predict how forest types will change in response to succession with and without disturbance events.

Predicting future vegetation communities is an exercise in modeling, based on the known responses to predicted disturbance for existing plant species. Comparing model results with known vegetation changes following disturbance validates models. There are a limited number of long-term vegetation plots on the Chugach National Forest portion of the Kenai Peninsula. These plots are valuable for "tuning" model results.

State and Private Forestry's Forest Health Protection group installed 30 1/5th-acre permanent plots in the Resurrection Creek drainage (ECOMAP Subsection M213B, Kenai Mountains) between Hope and Cooper Landing in 1976. While originally installed to document beetle populations and impacts to the forest overstory, other measures were added in subsequent years. Vegetation plots were installed in 1980 to track changes in understory vegetation. In 1984, a spring prescribed burn was conducted in the drainage to improve moose browse. While most overstory and understory vegetation was burned, only a minimal amount of mineral soil was exposed. Sixteen of the 30 plots were within the burned area. This permitted an evaluation of both the spruce beetle outbreak and fire effects on the understory plant succession. Plots were visited annually for the first five years, and have been monitored every 5 years since 1980.

Following the mid-September 1991 visit, changes in ground vegetation were documented (Holsten et al. 1995). There had been a significant increase in bluejoint grass and fireweed in both the burned and unburned plots. This report reflects understory vegetation and regeneration trends observed from the 1996 data collection. Only changes in several key understory components are considered (bluejoint, fireweed, tall and low shrubs, and regeneration).

Methods
Single 1-m^2 microplots were installed in in 1980 within each of the 30 1/5th-acre plots to assess understory vegetation changes. The microplots were established in areas selected to be representative of the vegetation on the larger plot. Each plant species was recorded and assigned a code to reflect its percent canopy cover range (Table 1). The plots were visited again in 1985 for data collection, but there was an error in the microplot placement and so the data could not be used for comparisons. Plots were visited again in mid-September of 1991, with correct placement of microplots. In mid-July of 1996, microplot data was collected again using the same methods, but by a different observer.

Table 1. Percent Canopy Cover Codes

Code	1	2	3	4	5	6	7
%Canopy Cover Range	0.1-5	5-20	20-40	40-60	60-80	80-95	95-100
Mid-range Value*	2.5	12.5	30	50	70	87	97.5

* Mid-range values were used as re-assigned canopy cover values for statistical analysis.

The Wilcoxon Signed Ranks Test (Conover 1980) was used on reassigned cover values (Appendix A) to determine if there were changes in canopy cover between 1991 and 1996 for bluejoint, fireweed, and shrubs. This test was also used to compare 1980 and 1996 cover values. Shrubs were grouped as tall or low, and sums of the reassigned cover values for each group were used to analyze change. Plots were grouped as either "burned" or "unburned", similar to Holsten and others (1995). Originally, plot 111 had been assessed as burned, and may have experienced a very light ground fire or only partially burned. Only four trees died from causes other than spruce beetles. As of 1996, 38% of the original trees were still alive. This plot was thus placed in the unburned category for this analysis.

Observing vegetation change from a single microplot is less than adequate to make good assessments of changes in the understory. During the 1996 visit, three additional microplots were installed on each plot. These were installed in a systematic manner to ensure good interspersion across each plot. Data from the new expanded microplot network cannot be compared to earlier data collection, but were analyzed for differences between unburned and burned plots. Mann-Whitney tests were used to determine differences in canopy cover of bluejoint, fireweed, tall and low shrubs between the burned and unburned plots.

In-growth within each plot was tallied in 1996. In-growth is the advanced regeneration that had grown to be 1 inch or more at DBH since the plots were originally installed. Tree seedlings on the center 1/100-acre of each 1/5th-acre plot were also tallied. We assumed that in-growth was present but too small to tally when the plots were originally established, and the seedlings have become established since 1976. Mann-Whitney tests were conducted to determine significant differences in tree stocking on burned and unburned plots.

Results

Understory Responses – Change over time

Average values over time of number of live trees per plot and percent canopy cover of bluejoint, fireweed, tall shrubs and low shrubs on the original microplot are displayed in Figure 1. Bluejoint showed a significant decrease from 1991 to 1996 in both unburned and burned plots ($p = 0.02$ and $p = 0.002$, respectively). Fireweed increased significantly in both unburned and burned plots ($p = 0.02$ for both) during the same period. There was no significant change in tall shrub cover in the microplots in either the unburned or burned plots. Low shrub cover decreased slightly in the unburned plots ($p = 0.06$) but did not change in the burned plots.

Figure 1. indicates that grass cover has returned to levels similar to 1980 in both unburned or burned plots. There is no significant difference between cover values recorded in 1980 and 1996. Fireweed has increased significantly between 1980 and 1996, however, in both unburned and burned plots ($p < 0.001$). Low shrubs have decreased in both unburned ($p = 0.003$) and burned plots ($p = 0.022$), but tall shrub cover has remained at about the same level throughout the same time period.

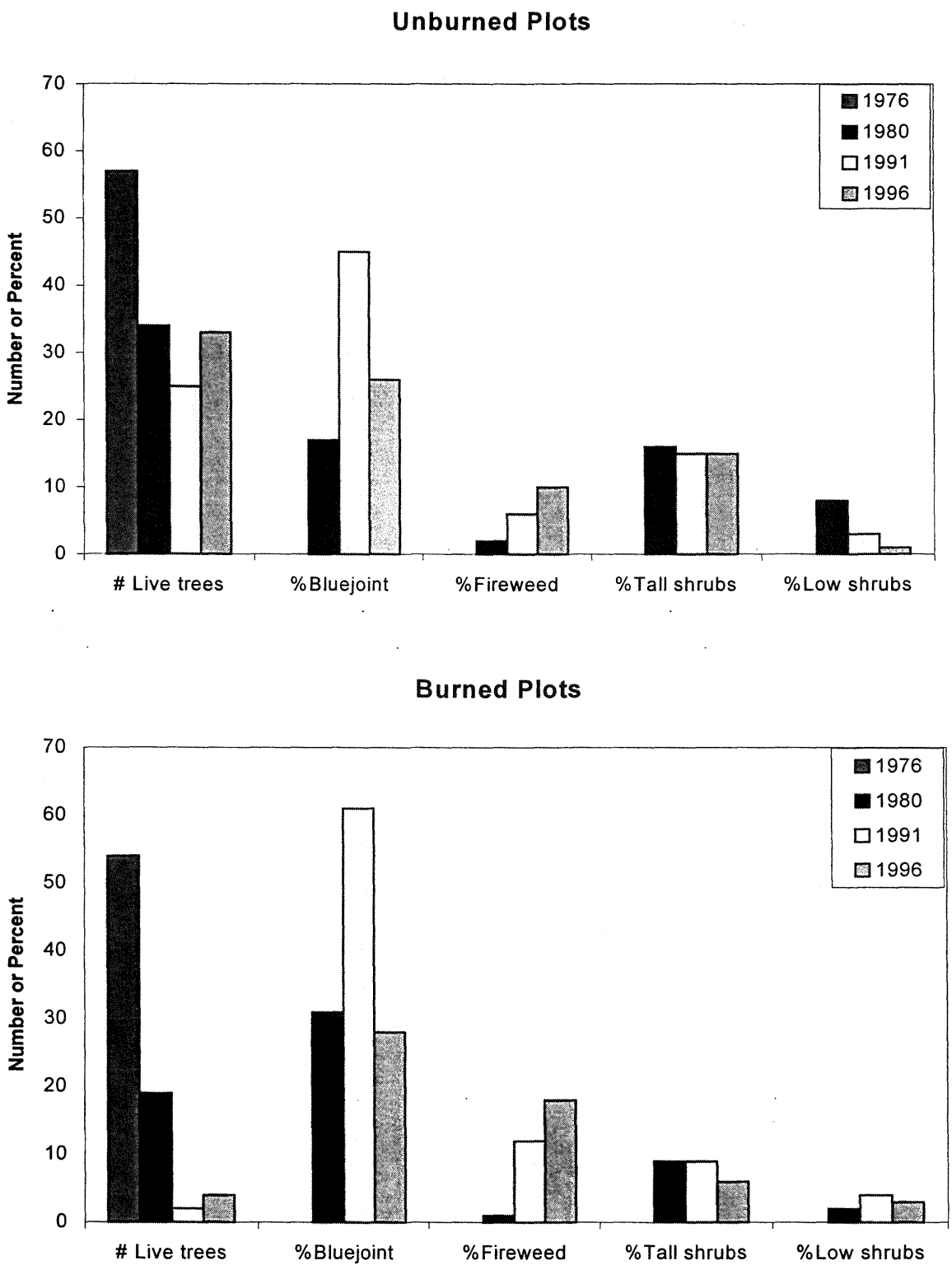

Figure 1. Average values of total number of trees and percent canopy cover of understory vegetation components in burned and unburned plots.

Differences between burned and unburned plots - Expanded plot network
A profile of the vegetation as of 1996 from the expanded microplot network is given in Appendix B. Frequency and average canopy covers for plants of interest are given in Table 2. For bluejoint and low shrubs, average canopy cover is not significantly different between the burned and unburned plots. Fireweed average canopy cover is significantly higher ($p < 0.01$) on the burned plots, and tall shrub average canopy cover is significantly greater ($p < 0.01$) on the unburned plots.

Table 2. 1996 frequency and average canopy cover of bluejoint, fireweed, tall and low shrubs as determined from expanded microplot network on unburned and burned plots.

	Unburned	Burned
Bluejoint	100/19	100/21
Fireweed*	100/9.2	100/18.8
Tall Shrub*	100/20.9	93.8/7.76
Low Shrub	36/1.13	25/2.33

* Significant differences ($\alpha < 0.01$) in average canopy cover between burned and unburned plots.

Tree Stocking
Tree stocking and regeneration on burned and unburned plots are summarized in Table 3. Stand composition in 1976 was similar on unburned and (yet-to-be) burned plots for all species except birch, which occurred more often in the burned plots ($p = 0.042$). Residual stocking of the original trees in 1996 was significantly greater in the unburned plots for all species except cottonwood ($p = 0.000003$, 0.055, 0.042 for spruce, hemlock, and birch, respectively). In-growth and seedling spruce were found significantly more often in the unburned plots ($p = 0.002$ and 0.012, respectively). Birch seedlings were found more often on the burned plots ($p = 0.073$).

Table 3. Tree stocking and regeneration summary, 1996 data.

		Unburned (n = 14)				Burned (n = 16)			
		1976	1996	In-growth	seedling	1976	1996	In-growth	seedling
Spruce	Avg.	53	22	7	2	49	2	1	0.31
	TPA	265	110	33	200	244	10	5	31
	Freq.	100	100	64	50	100	25	6	6
Hemlock	Avg.	1	1	1	0.07	1	0	0	0
	TPA	6	6	6	7	6	0	0	0
	Freq.	21	21	21	7	31	0	0	0
Birch	Avg.	2	1	0.21	1	4	0.13	0.38	8
	TPA	9	5	1	100	20	1	1	800
	Freq.	43	43	21	7	94	13	13	38
Cottonwood	Avg.	1	1	0.12	0	0.31	0.31	0	0
	TPA	5	5	1	0	2	2	0	0
	Freq.	14	14	14	0	6	6	0	0

Avg. = sum of total stems on 1/5th-acre plots/number of plots in group
TPA = computed trees per acre (plot size = 0.2 acre, seedling subplot size = 0.01 acre)
Freq. = 100% x (number of plots where item occurs/ number of plots in unit)

Discussion

Understory vegetation

Changes in percent cover of grass and fireweed may be explained to some degree by the timing of observations (Table 4).

Table 4. Timing of observations.

Year	Month, week
1980	September, 4th week
1991	September, 3rd week
1996	July, 2nd week

Traditionally, vegetation cover observations are timed after plant leaf tissue is fully expanded and before senescence begins. For south-central Alaska, this is usually from mid-July to mid-August. In 1996, vegetation may not have reached its peak biomass at the time of observation. The 1980 and 1991 visits may have occurred after frost, and percent cover could have been reduced from peak levels.

Timing of observations is probably more influential on fireweed and shrub cover than on bluejoint grass. July is about the peak for fireweed, but by September plants may have been affected by frost and leaf fall, and it would be difficult to visualize the plants at peak growth. Some shrub species were probably losing leaves by September, as well. July is also peak time for bluejoint. However, although grass is affected by frost, leaves remain intact on the plant and peak biomass can still be accurately assessed.

Differences in observers could also account for the changes in percent cover. Recording canopy cover by code helps minimize this potential for variance (Table 1). The codes represent a robust range of cover values, and the analysis is done using the mid-range value that the code represents.

The apparent reduction of grass cover between 1991 and 1996 is more likely reflective of the self-limiting nature of this species over time (Lieffers et al. 1993) and is consistent with finding from interior Alaska (Wurtz and Zasada N.d.). Holsten and others (1995) reported an increase in bluejoint grass, which is to be expected following disturbances that remove overstory cover. It could be speculated that grass reduction is a function of shading by in-growth of taller vegetation. On 64% of the unburned plots, a number of trees that were too small to be included in the original tree tallies had grown considerably and were tallied into the plot records in 1996. These trees are now 1 inch or greater in diameter at breast height and are large enough to provide shade. Grass growth is reduced when overstory canopy cover reaches 40 percent (Lieffers and Stadt 1993). There is some in-growth and sprouting on several of the burned plots since the fire in 1984, but probably not enough to explain the reduction of bluejoint except in localized areas.

It is not appropriate to compare the vegetation profile from the expanded microplot network with earlier results. However, the expanded microplot network will provide for a better assessment of vegetation changes in the future. It would also be inappropriate to assess browse production based on the vegetation profiles on these plots. The original plots were installed for monitoring spruce beetle impacts to the forest overstory. Plot locations were chosen with a bias towards spruce stands over browse species; no willow (*Salix* sp.) was documented on the burned plots prior to or after the fire (Holsten et al. 1995).

Tree stocking

Original tree stocking was reduced by spruce beetles on all plots, and then further reduced by fire on the burned plots. Neither disturbance agent resulted in an abundance of exposed mineral soil that would have been conducive to seedling establishment. In the Resurrection Creek drainage, dead trees are more likely to fail by stem breakage rather than by pulling up root wads. The prescribed fire was conducted in the spring. Live and most dead trees were standing, so the fire was primarily carried by cured grass from the previous year (Weixelman 1987). The fire was low in intensity, with little duff disturbance. It probably rejuvenated the existing bluejoint grass (Figure 1) while destroying any advanced spruce regeneration. Although some new seedlings have been found in both unburned and burned plots (Table 3), they were found on only 50 and 6 % of the plots, respectively. The advanced regeneration released in unburned plots will be an important component of the future forest structure, as will the birch sprouting in burned plots.

Summary

Vegetation plot data from the Resurrection Creek permanent plots suggest that bluejoint reed grass is becoming less vigorous twenty years after the initial spruce beetle outbreak. By 1996, grass cover in both unburned and burned plots was not significantly different than grass cover recorded in 1980. This supports other's observations that vigor is reduced as nutrients become immobilized in organic matter and canopy cover increases. Bluejoint grass cover was highest in the burned plots seven years following the prescribed burn. However, by 12 years after the fire, bluejoint grass cover was reduced to levels similar to the unburned plots.

Spruce in-growth was found on 64% and 6% of unburned and burned plots, respectively. Lack of spruce in-growth in burned plots suggests that the fire destroyed most regenerating trees. Spruce seedlings were recorded on 50% of unburned and 6% of burned plots. Minimal numbers of spruce seedlings in the burned plots may be attributed to a limited seed source following the fire. Birch seedlings were found on more burned plots than unburned (38% vs. 7%), reflecting species composition prior to the burn.

As we continue to monitor these and other long-term plots, we will be able to refine predictions of what future forests may look like. Additional studies to describe bluejoint grass dynamics and tree regeneration on both managed and unmanaged sites in various site conditions may be very useful in predicting Forest-wide trends.

Acknowledgements
This assessment was possible because of the initial plot establishment by the Forest Health Protection group, State and Private Forestry, US Forest Service Alaska Region and Tom Ward's work (USDA –NRCS) initiating ground vegetation microplots and data collection. Thanks to Vaughn and Sharon Salisbury, Ken Zogas, and Ed Holsten for help with data collection in 1996. Thanks to Rob DeVelice, Connie Hubbard, and John DeLapp, ecologists with the Chugach National Forest, for early reviews of this paper. The final version has greatly benefited from the careful reviews by Rob DeVelice, John Hard, and Ed Holsten.

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Appendix A. Percent canopy cover of understory vegetation on original microplot by plot.

Unburned Plots

	Bluejoint			Fireweed			Tall Shrub*			Low Shrub*		
Plot	1980	1991	1996	1980	1991	1996	1980	1991	1996	1980	1991	1996
101	2	97	70	2	0	13	0	0	0	0	0	0
102	2	30	2	2	0	13	72	30	30	2	0	0
103	30	13	2	0	2	13	15	26	15	6	6	4
104	50	50	30	0	0	13	2	30	2	2	0	0
105	0	87	50	13	13	13	13	2	0	15	0	0
106	2	2	2	0	13	13	30	13	50	13	13	2
107	0	0	2	2	13	2	32	15	26	45	0	0
108	13	97	50	2	13	2	2	2	32	0	0	0
109	30	87	50	0	2	2	2	0	0	2	0	0
110	50	87	13	2	13	30	2	13	2	2	0	0
111	30	13	13	0	0	2	0	0	0	0	0	0
112	30	0	50	2	2	2	4	30	28	2	0	0
113	2	13	2	0	13	13	2	0	0	15	15	2
114	2	50	30	0	0	13	43	45	30	2	2	0

Burned Plots

	Bluejoint			Fireweed			Tall Shrub*			Low Shrub*		
Plot	1980	1991	1996	1980	1991	1996	1980	1991	1996	1980	1991	1996
115	0	30	30	0	13	13	0	0	2	32	26	15
116	30	30	13	0	30	13	0	13	2	13	3	0
117	97	87	70	0	13	30	0	0	0	0	0	0
118	50	50	50	2	30	13	0	30	0	0	0	0
119	0	13	13	0	13	13	0	13	4	2	13	2
120	70	87	13	0	2	13	0	13	2	2	0	0
121	2	87	30	0	30	50	2	0	2	2	0	0
122	2	30	13	0	13	30	15	0	0	2	0	0
123	0	13	13	0	0	0	2	13	0	2	13	0
124	30	87	50	0	13	13	0	2	2	13	0	0
125	0	87	15	0	13	30	60	13	15	13	0	0
126	30	30	30	0	0	2	43	28	63	0	0	0
127	13	97	50	13	0	30	0	13	0	2	0	0
128	50	87	13	2	13	30	30	2	2	0	0	0
129	70	87	13	2	13	13	2	0	0	0	0	30
130	50	87	30	2	13	13	0	0	0	30	0	0

* Tall and low shrub cover values are sums of several species.

Appendix B. 1996 Groundcover and Vegetation Data: Average canopy cover on four microplots per plot. Unburned Plot

	Plots															
Forest floor	101	102	103	104	105	106	107	108	109	110	111	112	113	114	Freq.*	% Cov.
BRUSH	12.5	13.8	7.5	11.3	15.0	10.0	7.5	7.5	20.0	30.0	13.3	16.3	21.3	27.5	100.0	15.2
LOW GROUND VEG	15.5	32.5	47.5	5.0	-	12.5	28.8	48.3	41.3	-	17.5	21.3	20.0	16.3	85.7	25.5
LITTER	56.3	40.0	42.5	66.3	67.5	57.5	30.0	41.3	34.5	56.3	60.0	50.0	45.0	55.0	100.0	50.1
WOOD	16.3	13.8	2.5	17.5	17.5	8.8	20.0	-	19.3	13.8	9.3	12.5	13.8	1.3	92.9	12.8
Ferns and allies																
Athyrium filix-femina	-	-	-	3.8	-	-	-	-	-	-	-	-	-	-	7.1	3.8
Dryopteris dilatata	-	-	-		-	-	-	-	-	0.6	-	0.6	-	-	14.3	0.6
Equisetum arvensis	5.0	7.5	4.4	11.9	1.9	7.5	21.9	3.1	3.8	4.4	7.5	-	-	0.6	85.7	6.6
Equisetum silvaticum	-	-	-	1.9	1.9	-	-	1.3	10.0	0.6	-	1.9	14.4	10.0	57.1	5.2
Gymnocarpim dryopteris	3.8	5.0	11.3	8.8	8.8	-	7.5	6.3	32.5	5.0	-	31.3	14.4	13.8	85.7	12.3
Lycopodium sp.	1.3	3.1	1.9	-	-	0.6	-	1.3	4.4	0.6	-	3.1	1.3	1.3	71.4	1.9
Unknown fern	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	7.1	0.6
Graminoids																
Calamagrostis canadensis	18.1	1.9	14.4	21.3	40.6	33.1	1.9	15.6	21.3	16.9	26.3	30.6	7.5	16.3	100.0	19.0
Herbs																
Achillea borealis	-	-	-	-	-	3.8	1.3	-	-	-	-	-	-	-	14.3	2.5
Aconitum delphinifolium	-	-	-	-	-	0.6	0.6	-	-	-	-	-	-	-	14.3	0.6
Anemone sp	-	-	-	0.6	-	-	1.3	-	-	-	3.8	0.6	-	-	28.6	1.6
Aquilegia formosa	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	7.1	0.6
Artemisia Tilesii	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	0.6
Cornus canadensis	0.6	13.8	5.0	-	-	3.1	1.3	0.6	4.4	-	-	0.6	1.9	3.8	71.4	3.5
Delphinium glaucum	3.8	-	-	-	-	-	0.6	-	-	-	-	-	-	-	14.3	2.2
Dodecatheon pulchellum	-	-	-	-	-	0.6	0.6	-	-	-	-	-	-	-	14.3	0.6
Epilobium angustifolium	7.5	10.0	7.5	12.5	9.4	5.0	5.0	8.1	7.5	16.9	1.3	2.5	26.3	9.4	100.0	9.2
Galium trifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	7.1	0.6
Geranium erianthum	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	7.1	0.6
Heralcleum lanatum	-	-	-	7.5	0.6	-	-	-	-	-	-	-	-	-	14.3	4.1
Linnaea borealisi	-	3.8	1.3	-	-	1.3	1.3	1.3	1.3	-	-	0.6	0.6	3.8	64.3	1.7
Mertensia paniculata	6.9	7.5	-	11.3	4.4	5.0	1.9	0.6	-	0.6	-	3.1	-	-	64.3	4.6
Moehringa laterflora	-	1.3	-	-	-	1.3	-	-	-	0.6	-	-	-	-	21.4	1.0
Moneses uniflora	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	1.3
Petasites hyperboreus	-	0.6	-	0.6	-	1.3	-	-	-	-	6.9	-	-	-	28.6	2.3
Polemonium acutiflorum	-	-	-	0.6	-	3.1	-	-	-	-	1.9	-	-	-	21.4	1.9

Unburned Plots

Herbs, continued	101	102	103	104	105	106	107	108	109	110	111	112	113	114	Freq.*	% Cov.
Pyrloa asarifolia	-	-	-	-	-	-	-	-	1.3	-	3.8	-	-	-	14.3	2.5
Pyrola sp.	0.6	-	-	-	-	1.3	0.6	-	-	-	-	-	-	0.6	28.6	0.8
Pyrola secunda	-	0.6	1.3	-	-	-	-	-	0.6	0.6	-	1.3	0.6	-	42.9	0.8
Ranunculus occidentalis	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	7.1	0.6
Rubus arcticus	1.3	4.4	3.8	-	0.6	4.4	4.4	-	0.6	0.6	0.6	-	-	-	64.3	2.3
Rubus pedatus	-	-	5.0	0.6	-	-	0.6	1.9	4.4	0.6	-	4.4	1.3	1.9	64.3	2.3
Sanguisorba stipulata	0.6	-	12.5	6.9	10.6	18.1	7.5	-	-	-	0.6	0.6	-	-	57.1	7.2
Streptopus amplexifolius	-	0.6	-	-	-	-	-	-	-	-	0.6	-	-	0.6	21.4	0.6
Trientalis europaea	2.5	0.6	1.9	0.6	-	1.3	1.9	-	1.3	0.6	4.4	1.3	1.3	1.9	85.7	1.6
Valeriana capitata	0.6	-	0.6	1.3	0.6	1.9	8.1	-	-	3.1	0.6	-	-	-	57.1	2.1
Viola sp.	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	7.1	0.6
Shrubs																
Alnus crispa	-	-	-	-	-	-	-	15.0	-	-	-	10.6	-	25.6	21.4	17.1
Empetrum nigrum	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	7.1	0.6
Menziesia ferruginea	-	-	-	-	-	-	-	-	-	-	-	10.6	-	3.8	14.3	7.2
Ribes sp.	1.3	1.3	-	-	-	3.8	7.5	-	-	1.3	3.1	0.6	8.1	0.6	64.3	3.1
Rosa acicularis	3.1	8.1	1.3	3.1	0.6	-	4.4	0.6	-	7.5	-	-	3.1	-	64.3	3.5
Rubus idaeus	-	-	-	3.8	-	-	-	-	-	-	-	-	-	6.3	14.3	5.0
Salix barclayi	17.5	10.6	12.5	-	12.5	25.0	19.4	7.5	-	12.5	-	-	-	-	57.1	14.7
Spirea beauverdiana	-	-	6.3	-	-	-	-	-	8.1	-	-	-	-	-	14.3	7.2
Vaccinium vitis-idaea	-	-	0.6	-	-	-	1.9	1.3	0.6	-	-	-	0.6	-	35.7	1.0
Vibernum edule	-	-	-	0.6	-	-	-	-	0.6	3.8	-	12.5	-	-	28.6	4.4
Tree regeneration																
Betual papyrifera	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	7.1	0.6
Picea glauca x *lutzii*	-	17.5	0.6	-	-	-	1.3	-	-	-	-	-	-	-	21.4	6.5
Tsuga mertensiana	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	7.1	3.1

*Freq. Frequency = (number of plots where the item occurs / by the total number of plots) x 100%
% Cov. = (Sum of average percent cover per plot/ the number of plots where the item occurs)

Burned Plots

	Plots																	
Forest floor	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	Freq.*	%Cov.
LOW GROUND VEG	65.0	3.0	-	-	11.3	0.5	-	0.5	15.5	-	21.3	11.3	18.3	2.5	5.0	1.3	75	12.9
LITTER	27.5	60.8	87.5	95.0	62.5	85.0	91.0	82.5	67.0	87.5	68.3	73.8	66.3	91.8	71.3	81.3	100	74.9
SOIL	-	-	-	-	-	-	-	-	6.3	-	-	-	-	-	-	-	6.25	6.3
WOOD	7.5	26.3	12.5	5.0	26.3	15.0	7.8	17.5	11.3	12.5	10.5	18.8	15.0	7.0	23.8	17.5	100	14.6
Ferns and allies																		
Athyrium filix-femina	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.3
Dryopteris dilatata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	3.1	12.5	3.4
Equisetum arvensis	3.8	16.3	9.4	12.5	1.3	21.3	23.1	28.1	52.5	21.3	7.5	7.5	-	0.6	0.6	3.8	93.75	14.0
Equisetum silvaticum	1.3	0.6	9.4	-	-	-	0.6	-	-	-	-	-	6.9	11.9	11.3	5.0	50	5.9
Gymnocarpim dryopteris	3.1	5.0	8.8	1.9	7.5	6.3	16.9	5.0	16.3	12.5	8.1	3.8	23.1	12.5	6.9	9.4	100	9.2
Lycopodium sp.	-	-	-	-	0.6	-	-	-	-	-	0.6	-	0.6	-	-	-	18.75	0.6
Graminoids																		
Calamagrostis canadensis	11.9	18.8	50.6	21.9	10.0	26.3	35.0	16.9	7.5	26.3	7.5	11.9	23.8	21.9	31.3	40.0	100	22.6
Carex sp.	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	6.25	0.6
Herbs																		
Aconitum delphinifolium	-	-	-	-	-	0.6	-	-	0.6	-	-	0.6	-	-	-	-	18.75	0.6
Anemone sp.	-	-	-	1.3	0.6	-	-	3.1	-	-	-	1.3	-	-	-	-	25	1.6
Cornus canadensis	12.5	0.6	0.6	1.3	4.4	1.9	4.4	2.5	3.8	1.9	16.3	1.3	1.3	1.3	3.1	0.6	100	3.6
Delphinium glaucum	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	6.25	0.6
Epilobium adenocaulon	-	-	-	-	0.6	-	-	-	1.3	-	-	-	-	-	-	-	12.5	0.9
Epilobium angustifolium	14.4	21.3	16.9	16.9	9.4	16.9	45.0	25.6	3.8	21.3	14.4	1.9	16.3	30.0	26.3	21.3	100	18.8
Galium trifolium	0.6	0.6	-	1.9	-	-	0.6	0.6	1.3	0.6	-	-	-	-	0.6	0.6	56.25	0.8
Geum macrophyllum	-	0.6	-	0.6	-	-	-	-	0.6	-	-	-	-	-	-	-	18.75	0.6
Heralcleum lanatum	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.3
Linnaea borealisi	7.5	-	-	-	3.8	3.8	3.1	-	1.3	-	6.9	-	-	-	-	3.1	43.75	4.2
Mertensia paniculata	-	3.8	3.8	4.4	-	4.4	-	5.0	7.5	-	-	-	0.6	-	0.6	-	50	3.8
Moehringa laterflora	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	6.25	0.6
Petasites hyperboreus	-	-	-	-	-	-	-	-	-	-	-	1.9	-	-	-	-	6.25	1.9
Polemonium acutiflorum	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	6.25	0.6
Pyrola sp.	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	6.25	0.6
Pyrola secunda	0.6	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	12.5	0.9
Rubus arcticus	-	0.6	-	-	-	-	-	0.6	-	-	-	1.3	-	-	-	-	18.75	0.8
Rubus chamaemorus	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	6.25	0.6
Rubus pedatus	0.6	-	-	-	0.6	-	0.6	0.6	-	-	3.8	-	1.9	-	0.6	0.6	50	1.2
Rubus sp.	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.3
Sanguisorba stipulata	-	1.3	3.8	3.8	-	3.8	-	7.5	7.5	7.5	-	0.6	-	-	-	0.6	56.25	4.0

Burned Plots																		
Herbs, continued	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	Freq.*	%Cov.
Streptopus amplexifolius	-	-	0.6	-	-	0.6	0.6	0.6	-	-	-	0.6	-	-	-	0.6	37.5	0.6
Trientalis europaea	0.6	-	-	-	0.6	-	1.3	-	0.6	0.6	0.6	3.8	0.6	1.3	1.3	-	62.5	1.1
Valeriana capitata	-	0.6	-	0.6	-	0.6	-	1.3	3.8	-	-	-	-	-	-	-	31.25	1.4
Shrubs																		
Alnus crispa	-	-	-	-	12.5	-	-	-	-	-	-	15.6	-	-	-	3.1	18.75	10.4
Echinopanax horridum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1	6.25	3.1
Menziesia ferruginea	0.6	-	-	-	1.3	-	-	-	3.1	-	6.3	-	10.6	-	-	-	31.25	4.4
Ribes sp.	0.6	-	-	-	1.9	1.3	0.6	-	0.6	0.6	1.3	3.1	0.6	-	-	-	56.25	1.2
Rosa acicularis	0.6	1.9	-	7.5	-	1.3	0.6	1.3	6.3	1.9	3.1	-	-	1.3	0.6	-	68.75	2.4
Rubus idaeus	-	-	-	-	-	1.9	3.8	0.6	-	-	0.6	-	-	-	1.9	-	31.25	1.8
Spirea beauverdiana	0.6	-	-	-	-	-	-	-	-	-	-	-	3.8	-	-	-	12.5	2.2
Vaccinium vitis-idaea	5.0	-	-	-	3.1	-	0.6	-	-	-	-	-	0.6	-	-	-	25	2.3
Vibernum edule	-	-	-	-	-	-	-	-	-	0.6	-	6.3	-	-	-	0.6	18.75	2.5
Tree regeneration																		
Betual papyrifera	12.5	-	-	-	15.0	-	0.6	-	0.6	0.6	6.9	0.6	6.3	-	-	-	50	5.4
Picea glauca x *lutzii*	-	-	-	-	-	-	-	-	-	-	0.6	0.6	-	-	-	-	12.5	0.6

*Freq. Frequency = (number of plots where the item occurs / by the total number of plots) x 100%
% Cov. = (Sum of average percent cover per plot/ the number of plots where the item occurs)